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HANDLING AND SHIPPING STRAWBERRIES WITHOUT
REFRIGERATION

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INTRODUCTION

Motortrucks are being relied upon more and more for the transportation of strawberries from producing districts to markets that can be reached within 24 to 36 hours by this means. The Bureau of Agricultural Economics estimated that in the years 1933 and 1934, 53 percent of all strawberry shipments in the United States moved by this method.

Strawberries moved by truck are seldom refrigerated and often are exposed to very warm temperatures in transit. The use of precooling to control decay and maintain the fruit in good marketable condition during shipment in refrigerator cars as described by Rose and Gorman² obviously does not apply to truck shipments.

The purpose of the experiments here reported was to study harvesting, handling and packing methods, and other practices used with strawberries to determine how the loss in keeping quality, because of adverse temperatures in nonrefrigerated shipments, could be kept to the minimum.

MATERIAL AND METHODS

The strawberries used in these investigations were grown at Beltsville and Salisbury, Md., in 1934 and 1935, and at Willard, N. C., in 1935 and 1936.

The fruit from North Carolina was shipped by express or motor-truck to Washington, D. C., where it was inspected either the day of its arrival (1 day after harvesting) or the following day, or both. When time and fruit permitted, two inspections were made of each

¹ The writers wish to acknowledge their appreciation to Charles Dearing, superintendent of the Coastal Plain Experiment Station, Willard, N. C., and George M. Darrow, of the Division of Fruit and Vegetable Crops and Diseases, for furnishing facilities for some of this work; and to Dean H. Rose, R. C. Wright, and C. O. Bratley, who assisted with the inspections.

² ROSE, DEAN H., and GORMAN, E. A., JR. HANDLING, PRECOOLING, AND TRANSPORTATION OF FLORIDA STRAWBERRIES. U. S. Dept. Agr. Tech. Bull. 525, 58 pp., illus. 1936.

lot of fruit. The results of inspections made 1 day after harvesting are applicable to nonrefrigerated truck shipments from the vicinity of Wilmington, N. C., to points as far north as Baltimore, Md., or to similar shipments from Delaware and the Eastern Shore of Maryland and Virginia to New York City. The results of inspection on the following day are similarly applicable to shipments from North Carolina to New York City. The fruit obtained in Maryland was trucked to Washington, D. C., where it was inspected 1 or 2 days after harvesting. One test by nonrefrigerated express was made from Beltsville, Md., to New York City, the berries being inspected the day after harvesting.

In each test all lots were comparable at time of shipment. After arrival at market destination the percentage of sound, decayed,³ and bruised berries was determined. Unless otherwise stated, all figures relative to shipping quality are in percentage by weight, although the percentages were generally recorded both by weight and by number. However, the former expression is the most significant commercially, since it indicates the actual quantity of fruit falling into the various classifications regardless of size. When data are presented in percentages by number, those of sound fruit are slightly higher than when expressed in percentage by weight, because larger berries are more subject to bruising and decay.

The air temperature to which the fruit from North Carolina was subjected after shipment was approximately 60° F., whereas the holding temperature for the berries from Maryland was usually between 70° and 80°.

Some of the fruit harvested at Beltsville, and trucked only about 15 miles, was jolted for 8 hours on an apparatus designed to simulate longer transit conditions.⁴

The weather conditions in North Carolina in 1935 during the period when these experiments were conducted were especially conducive to the development of decay. A heavy rain fell on April 28 and was followed by rather warm weather during the week the test lots were shipped. Likewise, the fruit obtained from Beltsville, was generally poor in keeping quality because as a rule it was too ripe for distant shipment, there being a rather high percentage of full-ripe berries. The fruit obtained in North Carolina was more satisfactory in this regard, being about the same as usual in commercial shipments, with berries ranging from half ripe to full ripe.

INVESTIGATIONS ON HARVESTING

EFFECT OF TEMPERATURE AT TIME OF HARVEST

Stevens and Wilcox,⁵ working at Hammond, La., in 1917, concluded that when shipment is made under refrigeration, berries picked in the early morning are cool and less likely to decay than those picked during the heat of the day. In this study the same conclusion was reached when strawberries were shipped without refrigeration. The

³ In making these inspections no attempt was made to determine separate percentages for different kinds of rots.

⁴ ROSE, DEAN H., and LUTZ, J. M. BRUISING AND FREEZING OF APPLES IN STORAGE AND TRANSIT. U. S. Dept. Agr. Tech. Bull. 370, 15 pp., illus. 1933.

⁵ STEVENS, NEIL E., and WILCOX, R. B. FURTHER STUDIES OF THE ROTS OF STRAWBERRY FRUITS. U. S. Dept. Agr. Bull. 686, 14 pp. 1918. See p. 12.

results obtained, as presented in table 1, indicate the desirability of harvesting strawberries as early as possible in the morning while the temperature is relatively cool. It is interesting to note that the percentage of soft-bruised berries was rather closely correlated with the temperature at the time of picking. Apparently, picking the berries when they were warm was conducive to this type of injury.

TABLE 1.—*Influence of temperature at time of harvest on shipping quality of Blakemore strawberries; inspected 2 days after harvesting*

[Shipped by nonrefrigerated express from Wallace, N. C., to Washington, D. C.]

Date of picking	Time of picking	Temperature at time of harvest		Sound	Soft bruised	Decayed
		Fruit	Air			
		° F.	° F.	Percent	Percent	Percent
Apr. 30, 1935.....	6 a. m.-----	68	68	63.5	17.5	19.0
	9 a. m.-----	72	73	36.9	27.1	36.0
	12 m.-----	80	81	42.8	46.2	11.0
	3 p. m.-----	82	82	28.1	54.6	17.3
May 2, 1935.....	6 a. m. ¹ -----	58	59	69.4	12.9	17.7
	9 a. m.-----	79	79	53.4	33.0	13.6
	12 m.-----	89	85	34.7	47.8	17.5
	3 p. m.-----	84	80	71.7	24.1	4.2
May 6, 1936.....	7:30 a. m.-----	67	67	69.5	11.6	18.9
	11:30 a. m.-----	80	85	66.6	18.6	14.8
	2:30 p. m.-----	83	88	61.0	22.4	16.6

¹ Dew present.

EFFECT OF CARE IN HARVESTING

The results given in tables 2 and 3 on the effect of care in harvesting are self-explanatory. It can be readily seen that care to avoid injury in picking and handling at time of harvest resulted in better carrying quality. The results obtained with the fruit from North Carolina (table 2) illustrate the importance of having adequate supervision by a foreman who will insist upon careful picking and handling of the fruit. Much of the loss due to careless handling comes from infection by *Rhizopus*. It is important to note, therefore, that Stevens ⁶ reports "*Rhizopus* sp. does not readily penetrate the unbroken epidermis from the outside." See also Stevens and Wilcox ⁷ on this subject.

TABLE 2.—*Shipping quality of Blakemore strawberries as influenced by care in harvesting; inspected 2 days after harvesting*

[Shipped by express from Wallace, N. C., to Washington, D. C.]

Date of picking	Care in harvesting	Sound	Soft bruised	Decayed
		Percent	Percent	Percent
Apr. 30, 1935.....	{ Careful-----	63.5	17.5	19.0
	{ Careless-----	40.7	21.2	38.1
May 2, 1935.....	{ Careful-----	71.7	24.1	4.2
	{ Careless-----	26.4	36.2	37.4

⁶ STEVENS, NEIL E., PATHOLOGICAL HISTOLOGY OF STRAWBERRIES AFFECTED BY SPECIES OF BOTRYTIS AND RHIZOPUS. Jour. Agr. Research 6: 361-366, illus. 1916.

⁷ STEVENS, NEIL E., and WILCOX, R. B. RHIZOPUS ROT OF STRAWBERRIES IN TRANSIT. U. S. Dept. Agr. Bull. 531, 22 pp., illus. 1917.

TABLE 3.—*Shipping quality of three varieties of strawberries grown at Beltsville, Md., as influenced by care in harvesting; percentage of sound and of soft bruised strawberries 24 hours after picking and after holding in open air at 70° to 80° F.*

[Jolted for 8 hours after harvesting]

Method of harvesting	Dorsett		Blakemore		Fairfax	
	Sound	Soft bruised	Sound	Soft bruised	Sound	Soft bruised
Careful.....	Percent 78.3	Percent 18.3	Percent 88.0	Percent 6.3	Percent 100.0	Percent 0
Careless.....	64.7	35.3	84.8	11.5	84.2	15.8

EFFECT OF MATURITY ON SHIPPING QUALITY

The effect of maturity at harvest on the shipping quality of strawberries was studied, and the results are presented in tables 4 and 5. The term "half ripe" refers to berries showing 25 to 50 percent of the surface white and the remainder pink; "full ripe" is considered full eating ripe but not overripe; "nearly ripe" represents a stage of maturity intermediate between the other two.

TABLE 4.—*Relation of maturity to shipping quality; inspected 2 days after harvesting*

[Shipped without refrigeration from Wallace, N. C., to Washington, D. C.]

Date of picking	Method of shipping	Maturity at harvest	Sound	Soft bruised	Decayed	Color and flavor when inspected
Apr. 29, 1935 ¹	Express	Full ripe.....	Percent 25.6	Percent 41.9	Percent 32.5	A few berries over-ripe. Good-eating ripe; full color. Nearly full color but not quite full flavor.
		Nearly ripe.....	46.2	32.8	21.0	
		Half ripe (25 to 50 percent white).	52.3	33.3	14.4	
		Full ripe.....	66.7	(2)	33.3	
May 3, 1935	Truck	Nearly ripe.....	84.6	(2)	15.4	
		Half ripe (25 to 50 percent white).	93.7	(2)	6.3	
		Full ripe.....	13.2	66.4	20.4	
May 5, 1936	Express	Commercial (half to full ripe—mostly full ripe).	40.9	49.8	9.3	
		Half ripe.....	53.1	38.6	8.3	
		Full ripe.....				

¹ Calculated as percent by number on Apr. 29, 1935.

² Very few soft bruises were present in this shipment, and they are included under "decayed."

TABLE 5.—*Relation of maturity to shipping quality; harvested at Beltsville, Md., June 10, 1935*

[Jolted 8 hours]

Variety	Maturity at harvest	Inspected June 11			Inspected June 12		
		Sound	Soft bruised	Decayed	Sound	Soft bruised	Decayed
Blakemore.....	Full ripe.....	Percent 13.5	Percent 46.5	Percent 40.0	Percent 7.0	Percent 24.2	Percent 68.8
	Nearly ripe.....	73.3	14.7	12.0	40.6	3.5	55.9
	Full ripe.....	62.9	22.8	14.3	40.7	26.4	32.9
	Nearly ripe.....	93.4	3.0	3.6	73.6	2.4	24.0
Fairfax.....	Half ripe.....				88.9	5.3	5.8
	Full ripe.....	42.9	38.8	18.3	30.4	28.8	40.8
	Nearly ripe.....	75.4	17.8	6.8	63.8	22.1	14.1
	Half ripe.....				82.5	3.7	13.8
Dorsett.....	Full ripe.....						
	Nearly ripe.....						
	Half ripe.....						
	Full ripe.....						

Berries that were fully ripe when shipped carried very poorly in the absence of refrigeration. Considerable improvement in carrying quality was noted in berries picked nearly ripe, and still further improvement in those at the half-ripe stage. As shown in table 5, there were fewer sound berries 1 day after harvesting in the fruit picked when fully ripe than there were 2 days after harvesting in the fruit picked nearly ripe. Although fruit picked when half ripe had the best carrying quality, it did not develop full flavor and probably had not developed to full size in the field, although no measurements were made of increase in size during ripening on the plant. When berries are shipped without refrigeration to markets that cannot be reached within 24 hours after harvesting, the full-ripe stage is too ripe and the nearly ripe stage is more desirable. When it is necessary to hold the fruit at warm temperatures for a period of 2 days, the half-ripe to nearly ripe stage would be preferable, although as indicated in table 4, this would necessarily be at the sacrifice of color and eating quality. As shown in table 6, berries of three leading commercial varieties picked when fully ripe and held without refrigeration were mostly overripe in 2 days. Those picked when half ripe were not quite in prime condition for eating in 2 days, and those picked when nearly ripe were mostly full ripe the following day and were not generally overripe on the second day.

TABLE 6.—*Influence of maturity at harvest on degree of ripeness after 1 and 2 days at room temperature*

[Harvested at Beltsville, Md., June 10, 1935]

Variety	Maturity at harvest	Inspected June 11	Inspected June 12
Blakemore.....	{ Full ripe.....	Full ripe; few overripe.....	Mostly overripe.
	{ Nearly ripe.....	Nearly ripe to full ripe; mostly full ripe.	Full ripe.
Fairfax.....	{ Full ripe.....	Mostly full ripe; a few overripe.....	Mostly overripe.
	{ Nearly ripe.....	Nearly ripe to full ripe; mostly full ripe.	Full ripe; few overripe.
Dorsett.....	Half ripe.....	Nearly ripe to full ripe.
	Full ripe.....	Mostly overripe.
	Nearly ripe.....	Full ripe.
	Half ripe.....	Nearly ripe.

RATE OF RIPENING OF STRAWBERRIES AND ITS INFLUENCE ON FREQUENCY OF HARVESTING

In order to determine the rate of ripening, a number of strawberries at each of the three stages of maturity were tagged on the plant at various times during the 1935 season, and the daily amount of ripening was recorded. The results obtained in North Carolina are shown below.

Average time from—	Days
Half ripe to nearly ripe.....	1½
Nearly ripe to full ripe.....	1½
Full ripe to overripe.....	1⅔
Half ripe to overripe.....	5
Nearly ripe to overripe.....	3⅓
Half ripe to full ripe.....	3¼

The average temperature during this test was rather high, so that ripening probably proceeded somewhat more rapidly than usual, although conditions similar to these are to be expected during the

strawberry-harvesting season. No detailed temperature records were kept in the field during this test, but those obtained at the Wilmington, N. C., weather station (about 40 miles away) show a maximum of 88° F. and a minimum of 53° during this period. The average temperature was 72° (average of daily maxima and minima).

The data given on page 5 emphasize the importance of picking the plants clean of all berries of a suitable stage of ripeness. If strawberries are picked every other day when fully ripe, fruit that is missed would be overripe at the next picking under conditions similar to those prevailing during this experiment, and nearly ripe berries that are missed would be full ripe and of poor shipping quality at the next picking (table 4). If berries are picked every third day, both nearly ripe and full ripe berries that were not taken at one picking would probably be overripe at the subsequent picking, and if berries designated as half ripe in this report were not removed at one picking, they would probably be full ripe at the next picking and consequently of poor carrying quality.

Results on several varieties of strawberries similarly obtained at Beltsville are given in table 7. The average temperature during this period was 67° F., the minimum being 48° and the maximum 84°.

TABLE 7.—*Rate of ripening of strawberries of five varieties at Beltsville, Md., June 8 to June 12, 1935*

Interval from—	Blake- more	Fairfax	Dorsett	South- land	Bellmar
	<i>Days</i>	<i>Days</i>	<i>Days</i>	<i>Days</i>	<i>Days</i>
Half ripe to nearly ripe.....	1½	1½	1½	1½	1½
Nearly ripe to full ripe.....	2½	1½	1½	1½	1½
Full ripe to overripe.....	2	2½	2½	3½	2¾
Half ripe to overripe.....	5½	4½	5½	6½	5
Nearly ripe to overripe.....	4½	3½	4	5	4
Half ripe to full ripe.....	3½	2½	3	2½	2½

The results are generally in agreement with those obtained in North Carolina, the principal difference being that the period from the full-ripe to the overripe stage, and consequently the entire period from half to full ripe, was generally longer for the Maryland fruit than for the North Carolina fruit. This may have been due to the somewhat lower temperature prevailing at Beltsville during these experiments.

On the basis of the results obtained in North Carolina and Maryland it would seem advisable to pick strawberries at least every other day during warm weather and to take especial care that berries sufficiently mature for harvesting are not left in the field. This procedure would probably also reduce the amount of decay in the field, and thereby help to prevent the building up of sources of infection.

INVESTIGATIONS ON PACKING

EFFECT OF TYPE OF CRATE

The standard type of crate used in much of the eastern part of the United States has cleated dividers to separate the different layers, the cleats being intended to rest on the edges of the cups. The 32-quart crate of this type is shown in figures 1, *A*, and 2, while a 36-pint crate of the same type is shown in figure 1, *B*. This type of crate causes considerable damage to the fruit because the cleats on

the lid and dividers crush and cut the berries which project above the level of the cup. It was felt, therefore, that crates that do not involve the use of cleated dividers might prove more desirable. Accordingly, a series of shipping tests was made to compare different kinds of crates. Figures 3 to 9 illustrate the various types of crates and cups

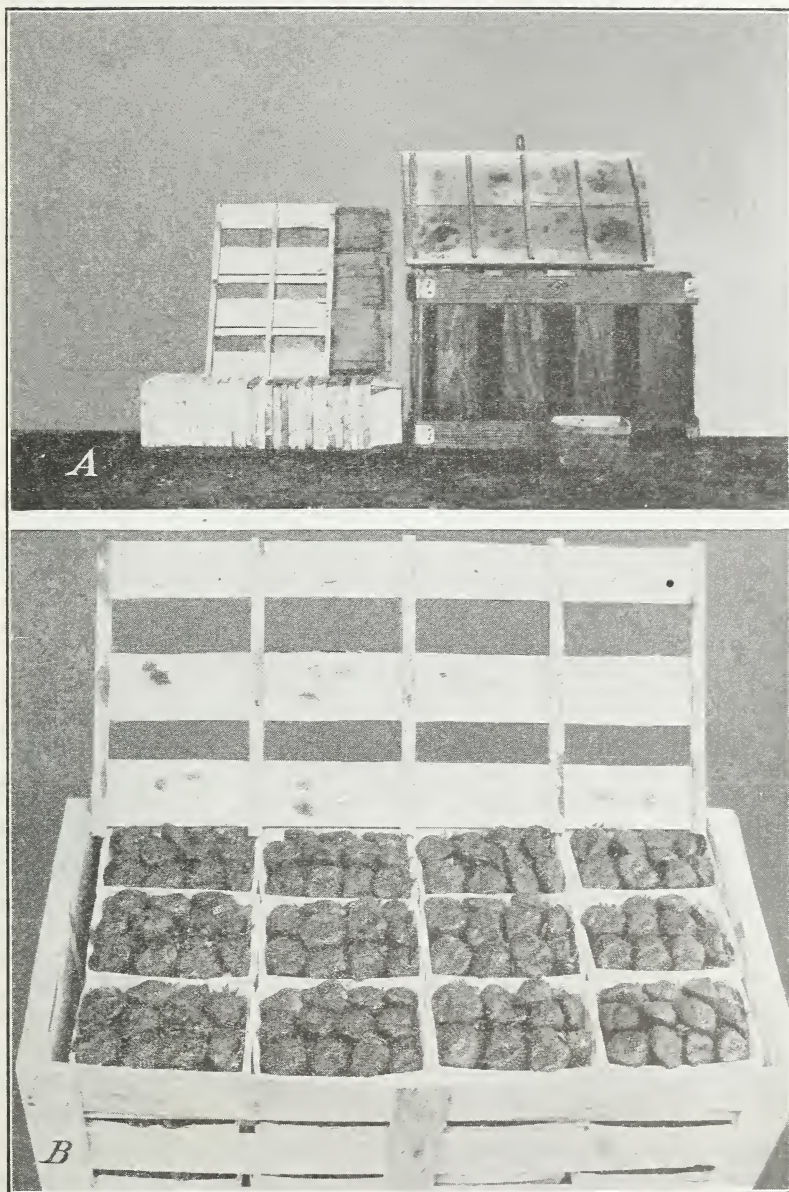


FIGURE 1.—A, Ordinary 32-quart crate, showing cups and dividers. Note stains indicating injury from cutting and bruising of berries. B, A 36-pint crate with cleated dividers. The stains on the top divider indicate the extent of cutting and bruising injury incident to use of this type of crate.

used in the experiments described hereafter. Some of the shipments were by express, others were by truck, and some of the tests on Beltsville berries were made on the jolting apparatus. The same varieties and the same methods of handling were used with all the crates of a single series. The results are summarized in table 8.

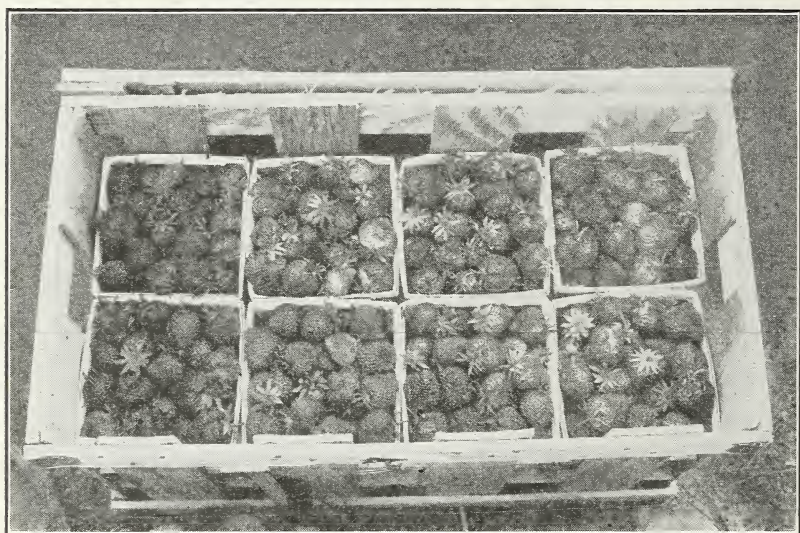


FIGURE 2.—Ordinary 32-quart crate partially filled with berries, showing condition of the fruit as packed before divider is put in place and the crate is closed.

TABLE 8.—*Influence of type of crate on average number of strawberries per cup that were crushed and cut or had flattened bruises, as determined in 12 tests, A-L*

CRUSHED AND CUT

Type of crate	Series											
	A	B	C	D	E	F	G	H	I	J	K	L
32-quart (regular)-----	4.25	3.3	3.6	1.7	1.7	2.3	1.53	3.75	4.0	1.75	0.75	1.22
24-quart (eared cups)-----	.12	0	.2	.5	.5	.3	.31					.33
24-quart (display)-----								0	.3	0	0	
16-quart (special)-----							.25					
24-pint (eared cups)-----	0	0	.1									

FLATTENED BRUISES

32-quart (regular)-----	5.1	5.0	3.1	3.2	1.7	3.9	2.25	4.75	8.0	4.25	3.75	3.44
24-quart (eared cups)-----	3.0	2.8	2.0	4.7	2.1	2.5	1.5					2.46
24-quart (display)-----								1.0	1.1	2.5	.6	
16-quart (special)-----							1.71					
24-pint (eared cups)-----	2.5	1.7	2.1									

From the results shown in table 8 it is evident that all the other crates were a marked improvement over the regular 32-quart crate with regard to the average number of cut and crushed berries found per cup. The same held true with respect to the average number of berries with flattened bruises per cup, though the improvement was

less marked and less consistent. In some of the later tests it was found that the number of flattened bruises in the 24-quart crate with eared cups (fig. 9) could be reduced by increasing the height of the ends one-fourth of an inch.

Obviously there would be fewer cut, crushed, or bruised strawberries if the 32-quart crate ordinarily used in shipment was replaced by

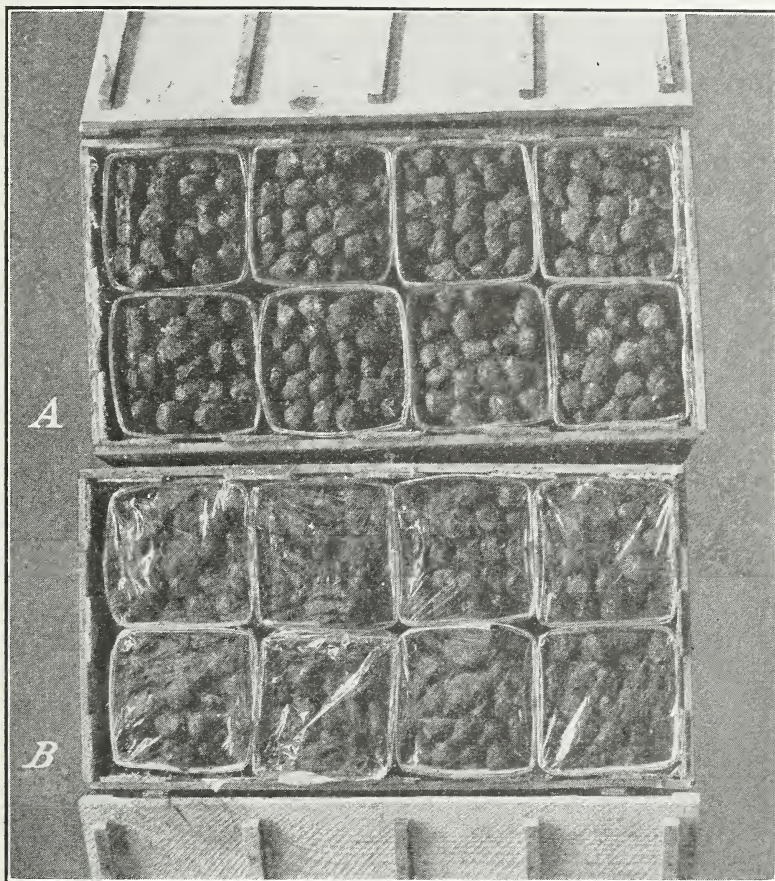


FIGURE 3.—A, Ordinary 32-quart crate as it reaches the market, showing cutting and bruising of the fruit due to pressure of dividers and lid. B, Same as A, with cellophane-covered cups. The cellophane afforded some protection from foreign material but did not materially enhance the market appearance of the berries.

one of the other types tested. Continued use of the 32-quart crate clearly nullifies much of the advantage gained by carefully grading the berries.

EFFECT OF PACKING IN THE SHED

The two common methods of packing strawberries were studied in test shipments from North Carolina to Washington and results are presented in table 9. In one method the berries were picked and brought to a shed to be sorted and packed, involving extra handling of

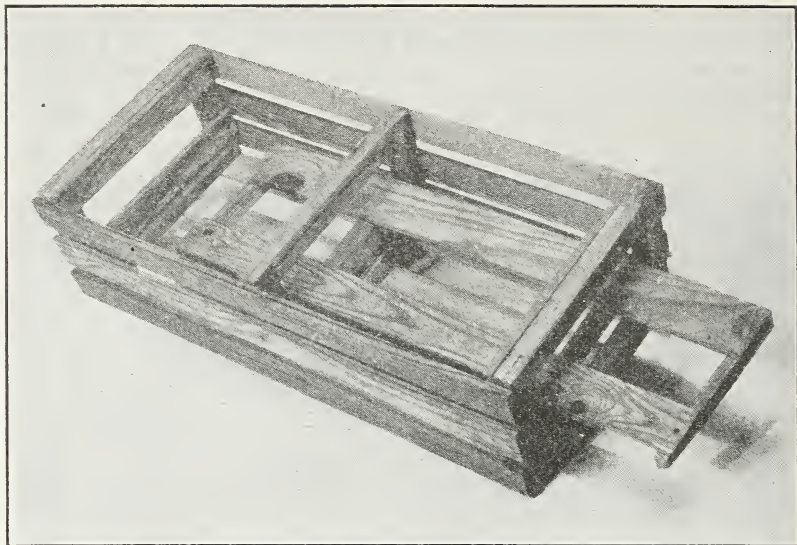


FIGURE 4.—Crate designed by the Coastal Plain Experiment Station, Willard, N. C., for shipment of strawberries without cutting or bruising from divider or lid. A sheet of cellophane is placed over each layer to keep the berries from falling out.

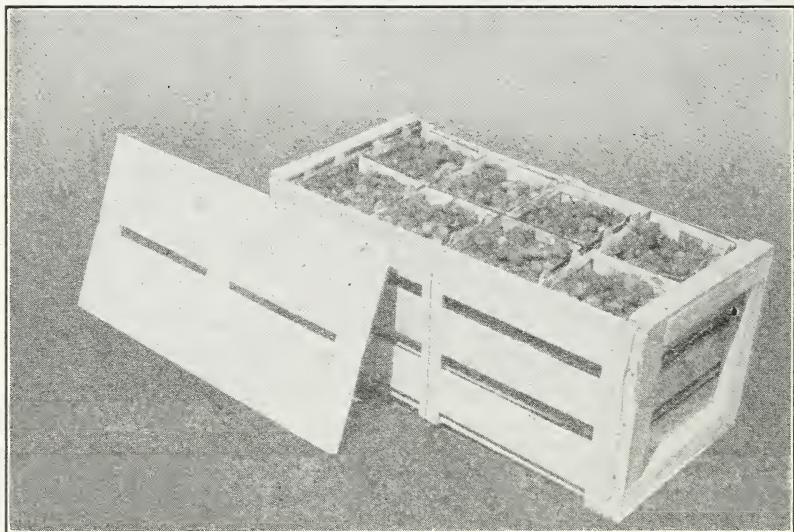


FIGURE 5.—Twenty-four-quart crate of heavy veneer wood with dividers similar to the ordinary 32-quart crate but used with "eared" cups which support the dividers away from the fruit.

the fruit; in the other method the grading was done in the field by the pickers. Generally the pickers are instructed to harvest only the grade of berries to be shipped and to leave the small, decayed, and otherwise defective berries in the field. In some instances a premium is paid to pickers who grade and pack the berries satisfactorily. Sometimes the picker makes two grades.

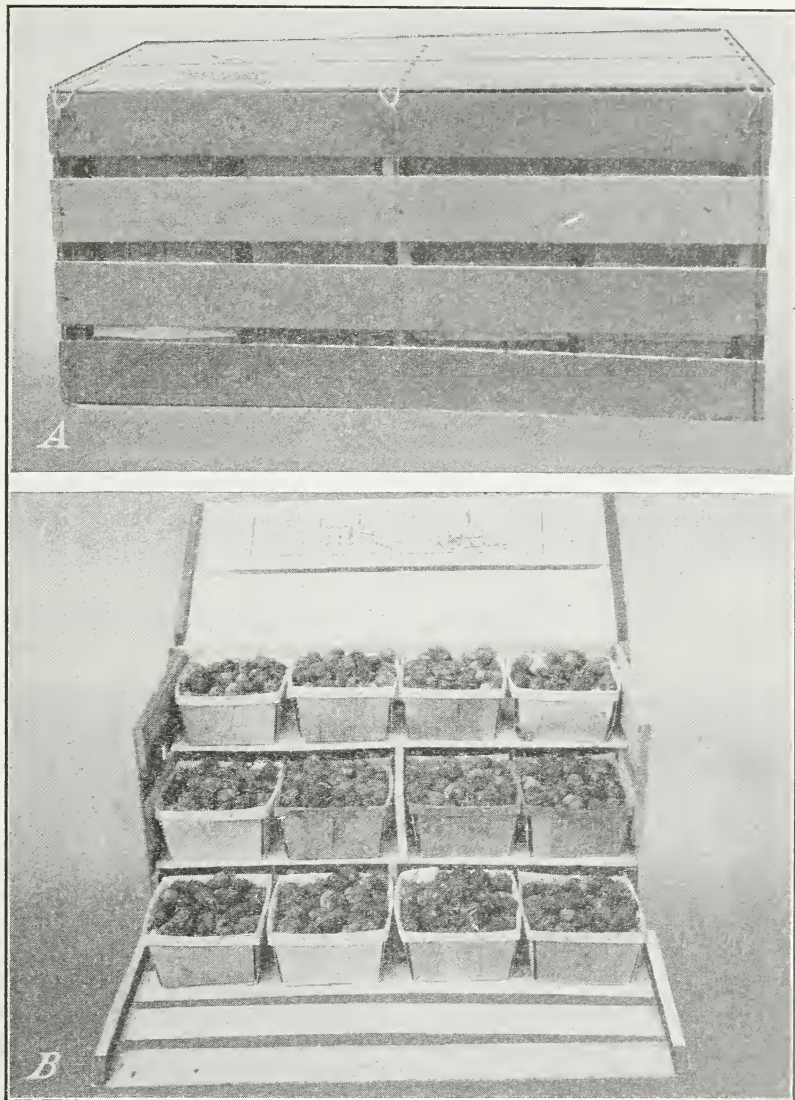


FIGURE 6.—A wire-bound berry crate designed to prevent injury of the berries in shipment and to facilitate display of the fruit in all layers: A, Closed for shipment; B, open for display of fruit.

It is evident from table 9 that careful picking and sorting in the field resulted in fruit of better shipping quality than was secured by rehandling and packing in the shed. The extra handling of the fruit involved in this latter practice markedly increased the quantity of soft, bruised berries. In series 3 it is evident that merely emptying the fruit on the table and then replacing it in the box caused an appreciable increase in decayed and soft, bruised fruit. In series 5 in which the ordinary picked fruit showed considerable decay when picked, the repacked fruit from which the decayed, soft, overripe, and otherwise

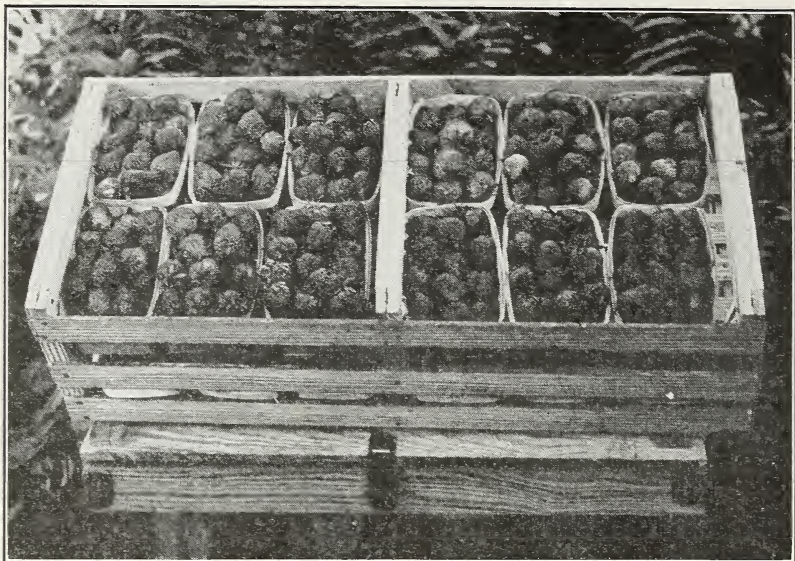


FIGURE 7.—A 24-pint crate of fancy Bellmar strawberries packed for shipment in the crate designed by the Coastal Plain Experiment Station, Willard, N. C. A sheet of cellophane is placed over each layer before putting in the divider or nailing on the lid.

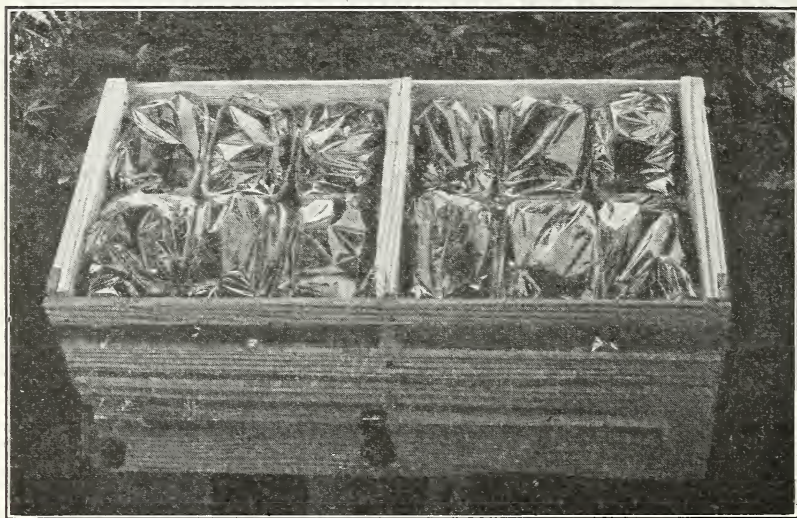


FIGURE 8.—Same as figure 7 except each cup is capped with cellophane held in place by a rubber band.

offgrade berries had been discarded did not have appreciably more sound berries upon arrival in Washington than the unsorted lot that was shipped just as harvested. The practice of repacking, of course, permits the preparation of a good-appearing pack, which doubtless brings a premium when sold at the shipping point. For this reason and others, such as the difficulty in securing very careful picking and

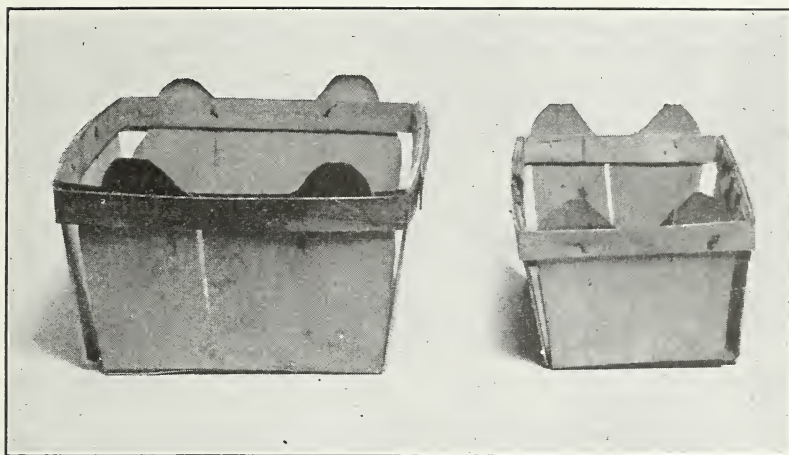


FIGURE 9.—“Eared” cups designed to reduce bruising and cutting of berries from pressure of dividers or lids.

the effect of leaving overripe and decaying fruit in the field, the practice of repacking in the shed may have some advantages, but the writers are inclined to agree with Stevens and Wilcox⁸ who suggest that when practicable, the berries should be sorted and packed as picked.

TABLE 9.—*Influence of rehandling and shed packing on the shipping quality of Blakemore strawberries, as compared with field packing*

[Shipped by express from Wallace, N. C., to Washington, D. C. Inspected after 2 days at air temperature]

Series No.	Method of handling	Date of picking	Sound	Soft bruised	Decayed
			Percent	Percent	Percent
1-----	Careful picking, field packing-----	Apr. 30, 1935	63.5	17.5	19.0
	Ordinary picking, packed in shed-----	do-----	48.6	19.8	31.6
2-----	Careful picking, field packing-----	May 2, 1935	69.4	12.9	17.7
	Ordinary picking, packed in shed-----	do-----	54.4	29.6	16.0
	Careful picking, field packing-----	do-----	71.7	24.1	4.2
3-----	Careful picking, packed in shed after emptying on table-----	do-----	52.8	37.2	10.0
	Careful picking, field packing-----	May 5, 1936	79.7	14.2	6.1
4-----	Ordinary picking, packed in shed-----	do-----	48.1	39.7	12.2
	Careful picking, field packing-----	May 6, 1936	61.0	22.4	16.6
5-----	Ordinary picking, packed in shed ¹ -----	do-----	43.2	40.9	15.9
	Ordinary picking, not packed ¹ -----	do-----	41.3	27.3	31.4

¹ Considerable decay was found in these lots when they were brought into the packing house.

COMPARISON OF FACED AND JUMBLE PACKS

The comparison of “faced” packs (arrangement of top layer of berries in the box in a regular manner with no stems showing) and “jumble” packs (merely filling the boxes, with no arrangement of berries) on the shipping quality of strawberries is given in table 10. The difference found between the two types of pack is not marked. Generally, there was a slightly higher percentage of sound berries in the jumble packs. The faced packs usually had slightly less decayed fruit but more soft bruising. The extra handling of the fruit neces-

⁸ STEVENS, NEIL E., and WILCOX, R. B. See footnote 5.

sary in making a faced pack resulted in a better appearing market package, and more decayed berries were discarded at the time of packing. On the other hand, this extra handling resulted in more soft bruising. In some cases also, it was noted that there was less slackness in the faced cups after receipt in Washington. This is explained by the fact that facing permits placing more berries in a box than when the box is not faced, even though both the faced and the unfaced cups are brought to the same apparent fullness. It is evident from table 10 that the average net weight per quart generally was a little higher in the faced cups.

TABLE 10.—*Comparison of shipping quality of faced and jumble packs*

Shipping test	Time between harvesting and inspection	Faced or jumble	Net weight per quart	Sound	Soft bruised	Decayed
	<i>Days</i>		<i>Grams</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
A-----	1	{Faced.....	598	75.8	22.9	1.3
		{Jumble.....	590	74.1	21.1	4.8
B-----	2	{Faced.....	604	70.1	14.6	15.3
		{Jumble.....	572	61.1	15.9	23.0
C-----	2	{Faced.....	570	40.9	49.8	9.3
		{Jumble.....	555	48.1	39.7	12.2
D-----	1	{Faced.....	589	40.4	51.5	8.1
		{Jumble.....	591	55.8	41.7	2.5
E-----	2	{Faced.....	595	42.8	41.2	16.0
		{Jumble.....	573	42.5	44.1	13.4
F-----	1	{Faced.....	706	68.8	25.9	5.3
		{Jumble.....	619	80.7	11.8	7.5
G-----	2	{Faced.....	653	52.2	17.7	30.1
		{Jumble.....	606	59.4	9.3	31.3

EFFECT OF CELLOPHANE CAPS

TABLE 11.—*Effect of cellophane covers for strawberry cups on quality of berries shipped by express from Wallace, N. C., to Washington, D. C.*

[Inspected 2 days after harvesting]

Variety	Date of picking	Sound		Soft bruised		Decayed	
		Not covered	Covered	Not covered	Covered	Not covered	Covered
		<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
Blakemore-----	Apr. 29, 1935	15.3	15.8	43.3	46.7	41.4	37.5
Do-----	do-----	15.2	12.4	44.6	47.8	40.2	39.8
Southland-----	do-----	15.6	19.5	36.3	28.6	48.1	51.9
Fairfax-----	do-----	36.6	40.5	40.9	29.8	22.5	29.7
Dorsett-----	do-----	20.4	24.5	46.3	30.6	33.3	44.9
Missionary-----	do-----	39.5	26.2	31.6	43.1	28.9	30.7
Klondike-----	do-----	39.3	43.3	18.1	21.7	42.6	35.0
Belmar-----	do-----	28.9	22.9	44.8	42.8	26.3	34.3
Blakemore-----	Apr. 30, 1935	63.5	70.5	17.5	9.2	19.0	20.3

At the time this study was made, there was considerable interest in North Carolina in the use of cellophane coverings for the berry cups, and several large shippers were using them on their fancy packs. Cellophane was used either as a covering for individual cups (figs. 3 and 8) or as a sheet placed between the layers of cups (fig. 7). The data obtained on the influence of cellophane covers on shipping quality of strawberries are presented in table 11. Apparently there

was no consistent difference in shipping quality between berries with and without cellophane caps. Cellophane covers might aid in enhancing the appearance of fruit or protecting it from foreign material, but their use interfered with the ventilation of the berries and seemed to increase the humidity inside the cup, thereby favoring the development of mold.

EFFECT OF TEMPERATURE ON DECAY

The results presented in table 12 illustrate the influence of temperature on the development of decay caused chiefly by rhizopus rot and gray mold rot. It will be noted that the percentage of decay increased with increasing temperatures up to 70° F., especially at those above 40°. Rose and Gorman⁹ recommend that strawberries that are to be shipped under refrigeration should be precooled to a temperature of 40° or slightly lower at the top and bottom doorway before shipment. This would mean an average fruit temperature of about 45° in the load. If this temperature is attained before rhizopus rot and gray mold rot get started the heavy losses that might otherwise develop can be prevented. See also Stevens.¹⁰

TABLE 12.—*Influence of temperature on decay of Blakemore strawberries after 3 days' storage*

[Harvested June 11, 1934]

Temperature (° F.)	Sound	Decayed ¹	Temperature (° F.)	Sound	Decayed ¹	Temperature (° F.)	Sound	Decayed ¹
	Percent	Percent		Percent	Percent		Percent	Percent
80-----	19.5	80.5	50-----	78.5	21.5	36-----	92.6	7.4
70-----	20.8	79.2	40-----	90.0	10.0	32-----	94.8	5.2
60-----	55.4	44.6						

¹ Chiefly rhizopus rot and gray mold rot.

In order to keep decay at a minimum in nonrefrigerated shipments it is necessary to shorten as much as possible the time that strawberries are held at high temperatures.

SUMMARY

Picking strawberries early in the morning while the fruit and air temperatures were relatively cool resulted in better shipping quality than picking later in the day.

Care in picking is an extremely important factor in the carrying quality of strawberries.

Berries harvested when fully ripe were of very poor shipping quality in comparison with those picked somewhat less mature.

Studies on the rate of ripening of strawberries in the field indicate the advisability of picking clean at least every other day, especially during warm weather.

It seems advisable to replace the standard 32-quart crate now in use with one designed to cause less crushing and cutting of the fruit.

⁹ ROSE, D. H., and GORMAN, E. A., JR. See footnote 2.

¹⁰ STEVENS, NEIL E. STRAWBERRY DISEASES. U. S. Dept. Agr. Farmers' Bull. 1458, 10 pp., illus. 1925. (Revised, 1933.)

Training the pickers to pick carefully so as to eliminate the necessity of repacking is advisable from the standpoint of shipping quality, if it can be accomplished. Frequent picking to lessen decay in the field and cultural treatments to reduce the number of small berries that should be graded out would be helpful in this respect.

The difference in carrying quality between "faced" and "jumble" packs was not marked. Facing results in a better appearing pack on the market.

In these tests there was no consistent difference in shipping quality between berries covered with cellophane and those not so covered.

Decay of strawberries was closely associated with temperature, especially above 40° F.

